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## Milling and utilization of hexaploid Triticale

### Introduction

Over one fourth of plant species are natural amphiploids (1). Triticale species are synthetic amphiploids obtained by duplication of chromosome number in sterile hybrids resulting from interspecific crosses between species of the genus Triticum and rye (Secale cereale).

Pertinent literature concerning these synthetic species has been recently reviewed by BRIGGLE (2). The first Triticale was obtained by RIMPAU in 1891 from a cross between hexaploid wheat and rye. In 1934, MÜNTZING (3) started a breeding programme to obtain lines of octaploid Triticale for practical use. In 1950, SANCHEZ-MONGE started a similar programme to obtain triticales with 42 chromosomes and suggested that this ploidy level should be nearer the optimum than the octaploid (4, 5). In 1954, a Canadian programme to obtain high yield triticales was initiated (6). As a result of these and other efforts, Triticale varieties are about to be released. SANCHEZ-MONGE, at the Instituto Nacional de Investigaciones Agronómicas in Madrid, is multiplying the hexaploid variety "Cachirulo" for its immediate diffusion. Originally, this variety was intended as a substitute of rye, barley or oats for animal feeding; and whole crop silage is quite satisfactory (7). However, its high yield under irrigation has led us to reconsider its utilization as a wheat substitute. As a result of seed shriveling, triticale has a greater proportion of peripheric endosperm and, consequently, a markedly higher protein content than wheat (20 % for triticale versus approximately 11 % for most Spanish wheats). On the other hand, seed shriveling results in lower milling yield. Improvement of triticale grain by breeding concomitantly reduces protein content.

The present paper deals with the experimental milling and the utilization of hexaploid triticale var. "Cachirulo" as a bread cereal.

### Material and methods

Samples. Hexaploid triticale, var. "Cachirulo" crop of 1968, was obtained from E. SANCHEZ-MONGE. A flour blend of four wheat varieties widely grown in Spain was used as reference in the evaluation of baking quality (F. Aurora, 10 %; Impeto, 10 %; Aragón-03, 30 %; Negrillo, 50 %).

Milling. A 10 kg sample of triticale was experimentally milled as outlined in fig. 1. Breaks were obtained with a Vario c. ex 2 mill (MIAG) according to specifications in table 1. Reductions and siftings were performed in a Buhler M.C.K. mill.

Table 1. Specifications for breaks in Triticale milling

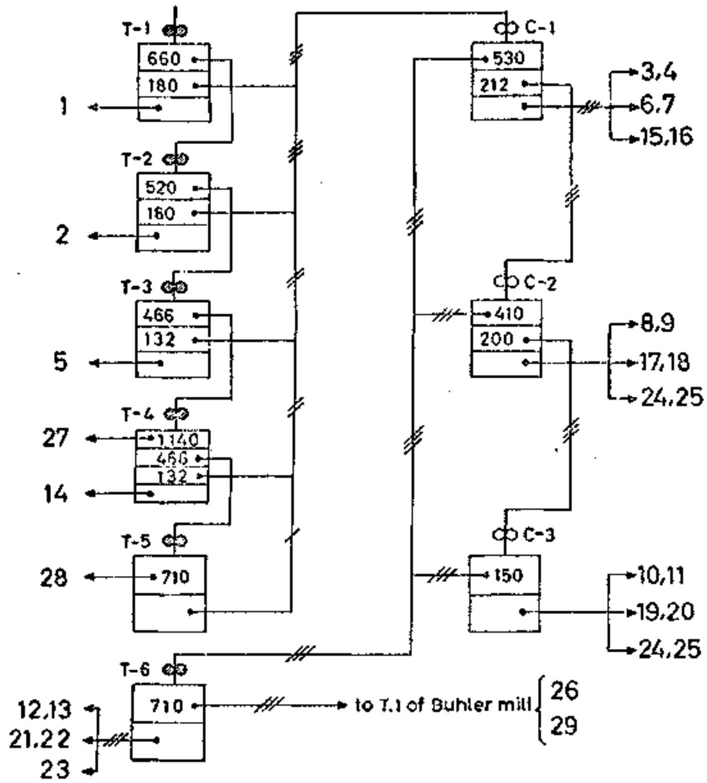
| Specifications | Breaks | | | | | |
|---|---|---|---|---|---|---|
| | B.1 | B.2 | B.3 | B.4 | B.5 | B.6 |
| Setting* | S:S | D:D | S:S | S:S | S:S | D:D |
| Fast roll speed $n_1$ (r.p.m.) | 600 | 200 | 800 | 1.000 | 1.000 | 300 |
| Slow roll speed $n_2$ (r.p.m.) | 300 | 800 | 200 | 200 | 200 | 800 |
| Speed ratio $\frac{n_1}{n_2}$ | 3:1 | 1:4 | 4:1 | 5:1 | 5:1 | 1:2,66 |

* S:S - sharp to sharp; D:D - dull to dull

A 2 kg sample of triticale was milled in the Buhler mill, to give three break flours and three reduction flours plus bran and shorts. Bran and shorts were pooled and run through the mill again to give three remilled fractions: flour, bran and shorts. All flours were pooled.

Quality evaluation. Routine determinations were carried out according to standardized procedures (8). Alveograph and farinograph curves were obtained by the I.C.C. tentative methods, except that, in the latter, 50 g of flour were mixed in the small bowl. Viscoamilograph curves were obtained to BRABENDER et al. (9), using 80 g of flour and 450 ml of water. The maltose figure was obtained by the amended RUMSEY method (10).

**Figure 1.**




Data of fractions

| Fract. No. | Yield % | Ash %db | Protein % db | Pooled products |
|---|---|---|---|---|
| 1 | 2.3 | 0.96 | 16.9 | |
| 2 | 2.6 | 0.86 | 17.1 | |
| 3 | 11.2 | 0.44 | 15.7 | Flour 1 |
| 4 | 8.1 | 0.62 | 16.4 | |
| 5 | 2.3 | 1.27 | 19.6 | |
| 6 | 9.0 | 0.57 | 19.0 | |
| 7 | 3.6 | 0.65 | 20.4 | |
| 8 | 1.5 | 0.94 | 19.4 | |
| 9 | 2.3 | 0.69 | 19.1 | Flour 2 |
| 10 | 0.3 | 1.50 | 19.5 | |
| 11 | 0.4 | 1.32 | 19.7 | |
| 12 | 0.7 | 1.35 | 19.2 | |
| 13 | 0.6 | 1.04 | 18.0 | |
| 14 | 2.7 | 1.95 | 22.5 | |
| 15 | 2.6 | 0.93 | 21.6 | |
| 16 | 1.3 | 1.20 | 23.5 | |
| 17 | 1.9 | 1.07 | 21.4 | |
| 18 | 0.8 | 0.99 | 23.0 | Concentrate 1 |
| 19 | 0.5 | 1.66 | 21.3 | |
| 20 | 0.2 | 1.96 | 23.0 | |
| 21 | 0.6 | 1.49 | 21.0 | |
| 22 | 0.2 | 2.13 | 21.0 | |
| 23 | 0.3 | 2.27 | 23.5 | |
| 24 | 0.6 | 1.87 | 24.4 | |
| 25 | 0.4 | 2.26 | 25.8 | Concentrate 2 |
| 26 | 9.5 | 1.75 | 24.0 | |
| 27 | 9.6 | 4.46 | 19.0 | Bran |
| 28 | 8.9 | 5.40 | 25.0 | Shorts |
| 29 | 15.0 | 5.11 | 25.6 | |

<u>Experimental baking</u>. The experimental baking procedure was essentially the standard method of the Institute for Cereal Research in Detmold (11), except that 300 g of flour were mixed in the Farinograph large bowl and rounded in the Extensograph.

## Results and discussion

The milling diagram yields 29 fractions which were analyzed for ash and proteins. Results are shown in fig. 1. The fractions were pooled into six final products as follows: flour 1 (protein < 18 %, ash < .8 %), flour 2 (protein > 18 %, ash < .8 %), concentrate 1 (protein > 21 %, ash < 1.5 %), concentrate 2 (protein > 24 %, ash < 2.0 %), bran (protein < 24 %, ash > 2.0 %), and shorts (protein > 24 %, ash > 2.0 %). Composition of the final products is presented in table 2.

Table 2. Chemical characteristics of Triticale products and wheat reference blend

| Product | Yield, % | Ash, % db | Protein, % db | Fat, % db | Fiber, % db |
|---|---|---|---|---|---|
| Buhler-flour | 63.0 | 0.67 | 18.2 | 1.5 | 0.6 |
| Flour 1 | 24.2 | 0.59 | 16.2 | 1.0 | 0.7 |
| Flour 2 | 20.7 | 0.77 | 19.3 | 1.0 | 0.8 |
| Concentrate 1 | 11.1 | 1.38 | 22.2 | 2.1 | 0.9 |
| Concentrate 2 | 10.5 | 1.78 | 24.1 | 3.0 | 1.8 |
| Bran | 9.6 | 4.76 | 19.0 | 3.7 | 11.0 |
| Shorts | 23.9 | 5.41 | 25.4 | 4.6 | 6.7 |
| Whole triticale | 100.0 | 2.35 | 20.8 | 2.4 | 3.4 |
| Wheat reference | - | 0.58 | 10.6 | 1.2 | 0.5 |

Flours and concentrates obtained by the above procedure, as well as triticale flour obtained as described by standard milling in the Buhler mill, were evaluated and experimentally baked, alone or mixed with the reference wheat blend.

Farinograph, Alveograph, and Viscoamilograph characteristics, as well as maltose figures, for the different products are summarized in table 3. Water absorption, development time and stability of the triticale products are above those of the wheat blend; tolerance index and the degree of softening are unfavorable with respect to the wheat blend in all products except concentrate 1. Valorimeter numbers indicate that farinograph characteristics of the triticale products, especially those of concentrate 1, are better than the reference wheat blend.

Table 3. Rheological characteristics and maltose figures

| Determination | Triticale | | | | | Wheat |
|---|---|---|---|---|---|---|
| | Buhler-flour | Flour 1 | Flour 2 | Concentrate 1 | Concentrate 2 | Reference blend |
| Farinogram: | | | | | | |
| Absorption, % | 64.5 | 61.1 | 66.3 | 71.1 | 84.6 | 54.8 |
| Development time, min. | 3.5 | 3.5 | 3.0 | 4.0 | 3.0 | 1.5 |
| Stability, min. | 3.5 | 3.5 | 4.0 | 4.0 | 3.5 | 2.5 |
| Tolerance index, B.U. | 130 | 125 | 120 | 100 | 140 | 110 |
| Degree of softening, B.U. | 165 | 160 | 160 | 110 | 200 | 125 |
| Valorimeter value | 41 | 42 | 40 | 50 | 38 | 37 |
| Alveogram: | | | | | | |
| L | 46.3 | 28.9 | 42.9 | - | - | 56.0 |
| G | 16.0 | 11.3 | 16.7 | - | - | 16.5 |
| W | 75.0 | 29.4 | 82.0 | - | - | 91.2 |
| H/L | 0.84 | 1.03 | 0.71 | - | - | 0.86 |
| Viscoamilogram: | | | | | | |
| Temperature of transition, °C | 58 | 58 | 58 | 58 | 47 | 58 |
| Temperature at maximum viscosity, °C | 67 | 67 | 67 | 65 | 64 | 89 |
| Maximum viscosity, U.V. | 60 | 80 | 60 | 50 | 30 | 1,280 |
| Maltose figure | 2.9 | 2.2 | 2.4 | 3.0 | 3.0 | 1.10 |

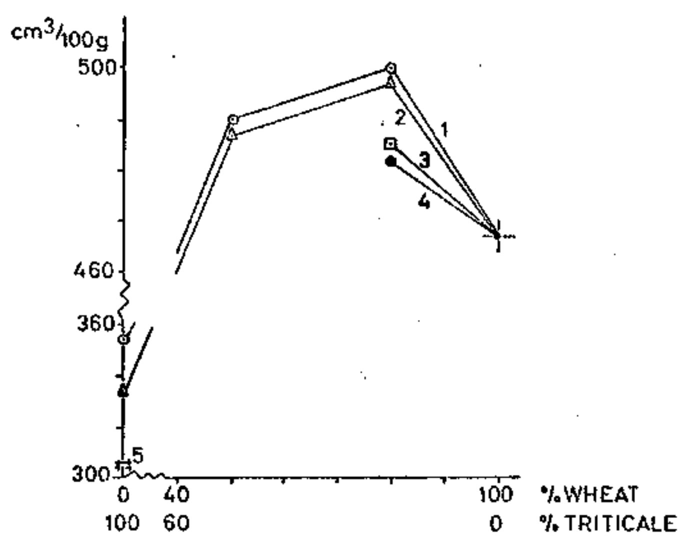
Alveograph data, although poorer than those of the reference, are within the normal values of Spanish wheat varieties and show well balanced H/L ratio.

All triticale products show high amilase activity. Viscoamilograph maximum viscosity and maximum viscosity temperature are very low, indicating exceptionally high alpha-amilase activity. Concurrently, high maltose figures indicate high beta-amilase activity, especially in the Buhler flour and the two concentrates.

Amilase activity distribution among the different milling fractions seems to be the result of the dominance of the peripheric over the inner endosperm. This characteristic is one of the main determinants in triticale utilization. The high amilase activity of all the triticale products used in this study, seems to preclude their use as sole components of bread, except when a high protein bread is desired for special dietetic purposes. For this reason, different mixtures of triticale products with the reference wheat blend were included in the baking tests.

Figure 2 shows variations of bread volume per 100 g of flour for different series of binary mixtures.

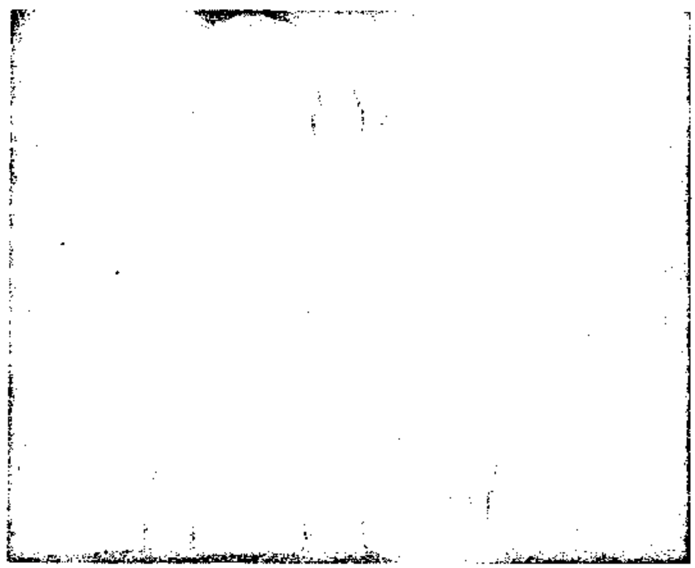
Figure 2. Variation of bread volume per 100 g flour with triticale content




(1) Flour 1; (2) Flour 2; (3) Concentrate 1; (4) Concentrate 2; (5) Buhler-flour.

Breads are shown in figure 3, and their quality characteristics (12) summarized in table 4.

Figure 3. Experimental breads



HTL-1 - Triticale flour 1, HTL-2 - Triticale flour 2, HTL-B - Triticale Buhler-flour. CTL-1 - Triticale concentrate 1, CTL-2 - Triticale concentrate 2, TRIGO - Wheat blend Florencia Aurora (10 %), Impeto (10 %), Aragón-03 (30 %), Negrillo (50 %).

Table 4. Bread quality*

| S a m p l e | External aspects | | Crumb characteristics | | | | Combined indexes | |
|---|---|---|---|---|---|---|---|---|
| | Form | Colour | Texture | Regularited of cells | Size of cells | Firmness | "Back-zahl" | "Wert-zahl" |
| Wheat | 0 | normal | 20 | 5 | 75 | 0 | 100 | 125 |
| Triticale: | | | | | | | | |
| Buhler-flour | -10 | strong | 10 | -5 | 50 | -5 | 15 | 5 |
| Flour 1 | -5 | strong | 10 | -5 | 50 | -5 | 32 | 27 |
| Flour 2 | -5 | strong | 10 | -5 | 50 | -5 | 21 | 16 |
| Mixtures: | | | | | | | | |
| Flour 1 (20 %) Wheat (80 %) | 0 | normal | 20 | 5 | 80 | 0 | 120 | 145 |
| Flour 2 (20 %) Wheat (80 %) | 0 | normal | 20 | 5 | 80 | 0 | 119 | 144 |
| Concentrate 1 (20 %) Wheat (80 %) | 0 | medium strong | 15 | 5 | 70 | 0 | 99 | 119 |
| Concentrate 2 (20 %) Wheat (80 %) | 0 | medium strong | 15 | 0 | 60 | 0 | 85 | 100 |
| Flour 1 (50 %) Wheat (50 %) | 0 | medium strong | 15 | 0 | 65 | 0 | 94 | 109 |

* Quality criteria according to H. DALLMANN (12).

As expected, low bread volumes and poor texture were obtained with the triticale flours. However, addition of triticale flours and concentrates at the 20 % level, and flours up to the 50 % level, increase bread volume. Triticale flours at the 20 % level also improve texture. Concentrate 1 at 20 % and flour 1 at 50 % yield quality characteristics similar to the reference wheat blend.

The combined indexes in table 4, "Backzahl" and "Wertzahl", allow the global evaluation of the different breads. According to this indexes breads elaborated with 20 % triticale flour are of significantly better quality than those elaborated with wheat blend. Triticale flours at 50 % and concentrate 1 at 20 % yield breads of similar quality as the reference; those of concentrate 2 at 20 % being of slightly poorer quality.

The above experiments show that triticale products can be used in breadmaking at levels of up to 20 %, increasing amilase activity which is usually low in wheat varieties harvested under the dry conditions prevailing in Spain. This results in higher bread volume and better quality in general.

From a nutritional point of view, the markedly high protein content of the hexaploid triticale var. "Cachirulo" versus wheats grown in Spain means an increase of the protein content of bread with the incorporation of this triticale.

## Summary and conclusions

The use in breadmaking of the hexaploid Triticale variety "Cachirulo", obtained by E. SANCHEZ-MONGE at the Instituto Nacional de Investigaciones Agronómicas in Madrid, has been investigated.

Several triticale products have been obtained by experimental milling and their quality characteristics have been assessed. All of them show high amilase activity, this being one of the determinant characteristics in connection with their use as bread cereals.

When baked alone, all triticale products yield low bread volume and poor texture. Consequently, they should be blended with wheat flour, unless a high protein bread for special dietetic uses is desired.

Triticale flour, at levels of up to 20 % and more, yield higher volume and better quality breads than the reference wheat blend used in this study, which has the somewhat low amilase activity of wheat varieties harvested under the dry conditions prevailing in Spain.

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